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<b>(21) International Application Number:</b> PCT/US97/21577 <b>(22) International Filing Date:</b> 25 November 1997 (25.11.97)  <b>(30) Priority Data:</b> 08/771,780 20 December 1996 (20.12.96) US  <b>(71) Applicant:</b> NORTON CHEMICAL PROCESS PRODUCTS CORPORATION [US/US]; 2855 Fishcreek Road, Stow, OH 44224 (US).  <b>(72) Inventor:</b> HARRIS, John; 508 Ivan Drive, Kent, OH 44240 (US).  <b>(74) Agents:</b> GORDON, David, P.; 65 Woods End Road, Stamford, CT 06905 (US) et al.		<b>(81) Designated States:</b> BR, CA, CN, JP, KR, MX, PL, RU, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).  <b>Published</b> <i>With international search report.</i>
<b>(54) Title:</b> FIXED VALVE  <div data-bbox="321 1144 690 1270"></div> <div data-bbox="795 1113 1274 1270"></div> <b>(57) Abstract</b> <p>A fractionation tray is provided which has perforations spanned by arch members (1) formed by deforming material from the material from which the tray (3) is constructed. The arch (1) has a ribbed underside shaped to divert gas rising through the perforation smoothly such that it encounters the liquid flow essentially at right angles.</p>		

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**FIXED VALVE**Background of the Invention

This invention relates to chemical process equipment in which a liquid is contacted with a counterflow of gas. This may be for a variety of purposes such as stripping a component from the liquid stream or absorbing a component into a liquid stream. More generically this invention relates to equipment designed to facilitate mass and/or heat transfer between phases.

The type of equipment to which this invention specifically relates employs cross-flow fractionation trays connected by downcomers. In such equipment a tower is provided with a plurality of fractionation trays arranged generally horizontally within the tower. Each tower has a perforated tray and at least one channel, called a downcomer, in which a liquid flowing over the tray may be collected and channeled to the tray below. In use a gas or vapor is introduced at the base of the tower and passes upwards through the perforations in the trays of the fractionation trays. Meanwhile a liquid is introduced at the top of the tower and percolates downward passing across the fractionation trays and down the downcomers to the tray below.

The trays are conventionally made of metal and particularly a metal adapted to withstand the environment in which it is expected to operate. Typically the metal will be a stainless steel. Such metals are relatively easy to engineer and trouble free while in use, though expensive in terms of materials.

Upon reaching each tray, the liquid flows across the tray in what is described here as the "design flow direction", which indicates the direction the liquid is intended to flow when the tray is operating in optimum design conditions. The tray is provided with a plurality of perforations through which gas bubbles continuously at a pressure that, under normal operating conditions, precludes the liquid from passing through the

perforation. These perforations are referred to as "valves" and it is to an improved design for such valves that this invention particularly pertains.

As indicated above, in the ideal process design, the liquid should be prevented from passing through the valves in the trays by the pressure of gas passing through the perforations in the upward direction. This is a finely balanced process since, if the pressure is too great, the gas will have a shorter transit time within the tower and less efficient contact with the down-flowing liquid. The high gas velocity may also cause liquid droplets to be carried up to the tray above, thereby reducing the separation efficiency as a result of back-mixing. On the other hand if the gas flow rate is too low the liquid will penetrate through the valves in the trays, (known as "weeping"), and short-circuit the flow patterns which are intended to maximize liquid/gas contacts.

Some valve designs actually allow the valve to close if the pressure drops too low. Such valves can however cause problems if they stick closed or only partially open. They are also expensive. Other valve designs merely place a cover over a perforation in the tray tray to prevent liquid falling on to the perforation with sufficient velocity to penetrate even when the pressure is at design levels.

The present invention provides a simple valve design that is obtained by a simple deformation of the material from which the tray is produced. Thus the tray can be produced, with the valves already in place, with no need for a further installation operation. Such arrangements are already known in principle but are often only partially unsuccessful at minimizing weeping.

The present invention provides a highly effective means of contacting liquid flowing over and around the valve with gas flowing up through the valve with reduced weeping and all in the context of a fixed valve formed by deformation of the material of the tray itself.

### General Description of the Invention

The present invention provides a fractionation tray having a design flow direction and at least one perforation therein formed by deformation of the material of the tray out of the plane of the tray to form an arch member spanning the perforation and oriented in the design flow direction in the vicinity of the perforation, said arch being provided with a centrally-located depression and correspondingly, on the underside of the arch member, a rib extending substantially the length of the arch member in the design flow direction.

In a conventional fixed valve the bridge member forces the gas rising through the perforation to exit laterally so that the gas contacts the liquid flowing around the leg members essentially at right angles. However the gas flow does not have any significant imposed directional component since it merely contacts the undersurface of the arch member and scatters in directions limited only by the attachment of the arch to the tray. In addition the energy in the gas flow is somewhat dissipated by the impact on the arch undersurface.

The novel contribution of the present invention is the provision of a central depression in the arch member which provides a corresponding central rib on the underside. Thus gas rising through the perforation encounters the rib which deflects the gas to either side of the rib with minimal reduction of the energy of the gas flow and maximum direction in the beneficial sideways direction.

In a preferred embodiment the depression is so deep that the lowest point of the rib above the surface of the tray is from about 30 to about 60%, and preferably from about 40 to 55%, of the maximum height of the arch above the tray.

The length of the rib is preferably at least 60% and more preferably at least 75% of the length of the perforation in the design flow direction.

The arch is connected to the tray in effect by legs which

are described as the "upstream" and "downstream" legs with the "stream" direction being the design flow direction.

In use a liquid flowing in the design flow direction across the tray encounters first of all the upstream leg member. This leg is solid and the liquid flow is split and directed to either side of the valve. As it passes the sides of the valve member it encounters gas flowing at right angles to the direction of flow of the liquid and directed smoothly in that direction by the central rib. This makes for very efficient gas/liquid contact.

### Drawings

Figure 1 is a plan view of a valve according to the invention.

Figure 2 is a cross-section at right angles to the design flow direction of the valve shown in Figure 1 at the midpoint of the arch member.

Figure 3 is a cross-section along the design flow direction at the center line of the valve shown in Figure 1.

### Detailed Description of the Invention

The invention is now further described with reference to the Drawings which are intended to illustrate the invention but are not to be understood as implying any essential limitations on the scope of the invention.

The device illustrated in Figures 1, 2 and 3 comprises a arch member, 1, spanning a perforation, 2 in the tray, 3. The arch is provided with a depression, 4, with a corresponding rib, 5, on the underside of the arch.

The arch is shown as a curved structure and indeed this is the preferred form as well the most simple to construct by deformation from the material of the tray. The depression and corresponding rib would then be located in the horizontal connecting portion of such a structure. It is therefore

understood that the present invention embraces also such alternative forms of arch.

In operation a tray has a large number of perforations which are usually circular, though other shapes such as elliptical and even polygonal are usable. The preferred locations of the perforations on the tray is in lines across the design flow direction with adjacent lines staggered such that the perforations in one line are between pairs of perforations in the lines on either side along the design flow direction. This ensures that the flows are repeatedly split and combined to ensure that no flow of liquid develops that is not contacted by the up-rising gas.

**CLAIMS**

1. A fractionation tray having design flow direction and at least one perforation formed by deformation of the material of the tray out of the plane of the tray to form an arch member spanning the perforation and oriented in the design flow direction in the vicinity of the perforation, said arch being provided with a centrally-located depression and correspondingly, on the underside of the arch member, a rib extending substantially the length of the arch member in the design flow direction.
2. A fractionation tray according to Claim 1 in which the lowest portion of the rib is located at from about 30 to 60% of the height above the tray surface of the highest point of the arch.
3. A fractionation tray according to Claim 1 in which the rib extends at least 60% of the length of the perforation in the design flow direction.

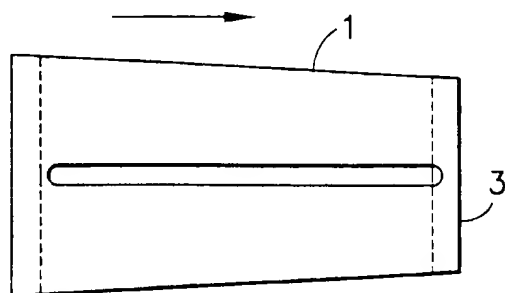


FIG. 1

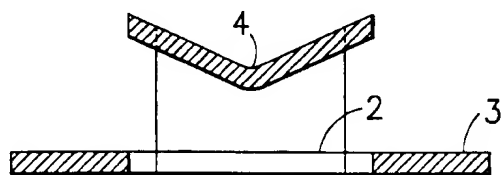


FIG. 2

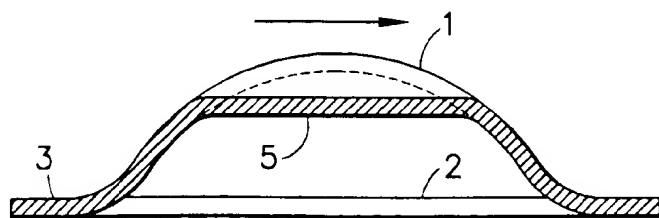


FIG. 3

# INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 97/21577

**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 6 B01D3/22 B01D3/16

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 B01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No
X	DE 22 23 654 A (STAGE HERMAN) 29 November 1973 see page 2, paragraph 4 see page 4, paragraph 3; figure 3 ---	1
X	FR 1 595 892 A (SOCIÉTÉ POUR L'ÉQUIPEMENT DES INDUSTRIES CHIMIQUES SPEICHIM) 24 July 1970 see figure 18 ---	1
A	US 3 759 494 A (AXELROD L ET AL) 18 September 1973 ---	
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☒ Patent family members are listed in annex.

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# INTERNATIONAL SEARCH REPORT

Information on patent family members

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